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SCIENTIFIC MANAGEMENT IN THE OPERATION OF RAILROADS

SUMMARY

Testimony before the Interstate Commerce Commission, 539. — "Scientific Management" to save railroads a million dollars a day, 539. — What is "Scientific Management?" — Its success in manufacturing establishments, 544. — Practically untried in railroad operation, 545. — Santa Fe experiments inconclusive, 546. — Differences between manufactories and railroads in extensive range of action (549). — Character of public service (550), and labor union influence, 553. — Progress of railroads in economical operation, 556. — Further progress possible by a more general adoption of best methods of best railroads, 559. — Difference between Scientific Management as a system and the best railroad methods not one in kind but in degree, 560.

The most striking feature of the recent public hearings before the Interstate Commerce Commission, in the matter of proposed increases in freight rates, was the charge of railroad inefficiency. Mr. Brandeis's clever turn in attacking the railroads in the quarter where attack was least expected called sharp attention to the subject of railroad management. The public was caught instantly by the dramatic statement that the railroads could save *a million dollars a day* through the adoption of a new system of scientific management, and their lively interest in it was kept up by newspaper and magazine discussion. In getting at the truth, the public had little constructive assistance from the railroads, and their disdainful attitude added to the first effect of the charges. The general impression, therefore, was that the railroads were needlessly deficient.

It is advisable to examine the charge of inefficiency apart from the rate question, which is now settled.[1]

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[1] In its decision of February 22, 1911, on proposed advances of rates by carriers in official classification territory, the Commission says: "It is difficult to see exactly

It is, perhaps, comprehensible that the railroads, already harried by public attack and suspicion, and now reproached unjustifiably, as they think, should be indignant at being presented with a new pill to swallow. Perhaps they may be pardoned for looking on it as a quack remedy. But it behooves the student of railway problems to examine the new prescription carefully and, so far as may be, impartially to inquire whether the railroads have some justification for distrust, to ascertain if the extent of waste is as great as suggested, to indicate some of the limitations on the adoption of any system of scientific management, and to suggest what may be learned with profit from its advocates.

It is necessary at the outset that we have a clear understanding as to what is meant by scientific management. To obtain it, we will go at once to headquarters. Mr. Frederick W. Taylor, consulting engineer, Philadelphia, is acknowledged as the dean of the efficiency experts and the originator of the new system. Mr. Taylor was conspicuously successful in his management of the Midvale Steel Company, where he was successively laborer, foreman, superintendent, and general manager. There his system was first worked out. In addition, he has also made an international reputation as the inventor of high-speed steel for metal-cutting tools and drills, an achievement in itself

what application the Commission can make in this case of this testimony [on scientific management]. The witness who apparently had most to do with originating and applying these methods testified that they were in actual operation in not over one tenth of one per cent of all the manufacturing establishments of this country. The system is everywhere in an experimental stage. To some extent it has been tried and is now being tried by our railways. The representatives of railway labor who appeared before us stated that these methods could not and should not be introduced into railway work. Upon this record, we can hardly find that these methods could be introduced into railroad operations to any considerable extent, much less can we determine the definite amount of saving which could be made. We cannot therefore find that these defendants could make good any part of these actual advances in wages by the introduction of scientific management."

sufficient to stamp him as a man of remarkable scientific attainments. The history of the gradual evolution of his system of shop management, his successful efforts to systematize and conserve labor, and the experiments in evolving high-speed steel, reads like a romance.[1]

The fundamental principles of Mr. Taylor's system are definite, and are set forth by him as follows: [1] —

> *First.* Each man in the establishment, high or low, should daily have a clearly defined task laid out before him. This task should not in the least degree be vague or indefinite, but should be circumscribed carefully and completely, and should not be easy to accomplish.
>
> *Second.* Each man's task should call for a full day's work, and, at the same time, the workman should be given such conditions and such appliances as will enable him to accomplish his task with certainty.
>
> *Third.* He should be sure of large pay when he accomplishes his task.
>
> *Fourth.* When he fails he should be sure that sooner or later he will be the loser by it.
>
> When an establishment has reached an advanced state of organization, in many cases a *fifth* element should be added, namely, the task should be made so difficult that it can only be accomplished by a first-class man.

Under the first principle, the difference between the Taylor plan and ordinary practice lies in the very careful study (by experts with stop watches) of each element in each task, so that definite information is available as to how long it should take. In ordinary practice, the fixing of piece-work rates is left to the judgment of the foreman or piece-work specialist, and the rates are often changed. Under Mr. Taylor's plan rates are inflexible unless conditions change.

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[1] The writer attended Mr. Taylor's several lectures before students in the Graduate School of Business Administration, Harvard University. He has also seen the practical application of the new system in the plant of the Tabor Manufacturing Company of Philadelphia, where Mr. H. K. Hathaway, vice president of the company, took considerable time and pains to explain it thoroly. Scientific management has practically revolutionized the work of the establishment. Before its introduction there were more than 100 workmen at the machines and less than 6 men in the office; now there are 70 workmen in the shop and 30 men in the office and planning department and the output has been increased over 300%.

[1] From a paper read by Mr. Taylor before the American Society of Mechanical Engineers, June, 1903. Mr. Taylor is a former president of the society.

In the application of the second principle, Mr. Taylor goes much further than is customary in standardizing tools and machine accessories, and systematizing the storing and distributing of materials, sharpening of tools, and the like. Two unique features are the planning department and functional foremanship, the latter calling for a corps of specialists, each with a single function, instead of the military type of organization, under which the foreman is responsible for the work and discipline of all the men under him and all the machines which they use. The planning department is designed to take out of the hands of foreman and men all the planning of work and how it is to be done. The workman is merely to act upon written instructions. To make sure that the work is properly performed, the supervision formerly divided between the superintendent and foremen is assigned to a number of persons: (1) the gang boss, who has charge of the preparation of all work up to the time it is set in the machine; (2) the speed boss, who sees that proper cutting tools are provided and machines properly operated; (3) the inspector, who is responsible for the quality of the work; (4) the repair boss, who sees that the workmen keep their machines clean and properly oiled; (5) the route clerk, who lays out the exact route by which each piece of work must travel from machine to machine; (6) the instruction card man, who has charge of making up written instructions for each job; (7) the time and cost clerk, who prepares accurate cost data; and (8) the shop disciplinarian, who handles all matters of discipline and adjustment of disputes.

The foregoing briefly describes what is meant by scientific management *in shops.* As a system, its details have been well developed and it is in successful operation in a number of important manufacturing establishments. For branches of railroad work outside the shops, however, no definite plan has been worked out, nor have any experiments been made to determine whether the principles or details of *shop* scientific management are superior to the best practice of well-managed roads in activities outside of the shops.

Mr. Brandeis, in his brief in the rate controversy, is not so definite. He describes scientific management as involving a careful analysis of each unit, and a comparison of each of the smallest steps in the process with an ideal of perfect conditions. The system means, he says, that before anything is done, it must be determined what shall be done, how it shall be done, and what it shall cost. Planning in advance, he explains, is the essence of the new system. It affords a stimulus to workmen in the form of a higher rate for greater output. It shifts the burdens of management from employee to the management, where they belong. It demands universal preparedness, full and complete records, and the ascertainment and application of the best attainable methods, practices, tools, and machines; and it means further that all tools, machines, and appliances shall be properly standardized and in perfect condition.

This summation is admirable so far as it goes, but it is incomplete. The features which fail to get mention are very important and probably are those upon which Mr. Taylor would place strong emphasis. Nothing is said about the long time required for patient and careful study in the introduction of the Taylor system, nor its delicacy of adjustment, calling for thoro and painstaking effort. There is no reference to the difficulty of finding exceptionally skilled experts to specialize in the new field of transportation. The number of such experts is exceedingly small. These omissions in setting forth the scope and plan of scientific management are of serious consequence, since the public is only too ready to believe in new treatments, and as a result a swarm of unqualified or imperfectly qualified " physicians " is already appearing. The railroads are continually importuned to adopt schemes or devices which their originators believe will bring large returns, but which are obviously impractical or are likely to be vitiated in experience by some fatal defect. After many experiments of this kind, the railroads are naturally wary or skeptical. It is of the greatest importance, both for the railroads and the system of scientific management, that a clear distinction be made between the genuine thing and the poor copy. Amidst diversity and disagreement of doctors, railroad men, with large responsibilities, may well hesitate and insist upon proof before accepting the new doctrine.

To what sources may they turn for this proof? Unfortunately, a convincing demonstration, either affirmatively or negatively, is yet to be made in railroad operation. Only in textile mills, printing and binding concerns, and other manufacturing establishments, is there ample proof that scientific management is both practicable and profitable, that it has increased output and at the same time decreased cost. The testimony before the Interstate Commerce Commission is replete with concrete illustrations of substantially increased net returns, notably in the cases of the Yale & Towne Company, The Link Belt Company, Tabor Manufacturing Company, Brighton Mills, and Plimpton Press.

The only instance of the application of something similar to the Taylor system in railroad operation is the experiment made on the Atchison, Topeka & Santa Fe Railway in 1904–07 by Mr. Harrington Emerson, president of the Emerson Company of New York, who are standard practice and efficiency engineers. Mr. Emerson is the author of the inspiring book, *Efficiency*, and an earnest advocate of advanced methods of securing efficiency. He has had a wide experience in installing his system in industrial establishments and has devoted much time to developing a plan particularly adapted to railroad shops. The results, as described in articles by the editor of the *Engineering Magazine* and by Mr. Emerson himself in several articles and lectures, indicate on their face that the workings of the new system were remarkably successful. In selected items of expense and unusual units of cost, large savings are shown. In one minor item, the maintenance of belts, astonishing results were achieved by more scientific treatment from workman to purchasing agent.

It will be remembered that Mr. Emerson was the authority for the statement that the railroads, by the adoption of scientific management, could save a million dollars a day. While it is not clear from his testimony before the commission, Mr. Emerson has stated elsewhere how he arrived at his estimate of a million a day.[1] He took the last statistical report of the Interstate Commerce Commission and applied to each grade or class of employee and cost of materials the percentage of efficiency obtaining in railroad operation at this time, according to his observation and judgment. Thus he ascertained what it would have cost to run all the railroads at 100% efficiency. He believes, for instance, that shops are but 60% efficient; section forces, less than 50%; stationmen, 60% to 80%. Applying the same process and reasoning to the cost of materials, he estimates, for example, that fuel consumption is but 50% efficient. It requires an average saving of approximately 23% in *all* items of expense to reach a million per day. If the saving applied only to the accounts specifically referred to, namely, section forces, shops, fuel, and freight stations, it would be necessary to reduce each of these by 50%. In either case, the operating ratio must be cut down from 66% to 51%. The result would be also that 310,000 workmen out of a total of 1,500,000 would be dispensed with.

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[1] The writer had the pleasure of discussing this subject personally with Mr. Emerson.

Since this one example of efficiency methods is held up to the railroads for emulation, it is advisable to call attention to certain conditions, not emphasized in the descriptions of accomplishments; not with any thought of minimizing the good that was accomplished while Mr. Emerson was with the Santa Fe, but to explain why the results of the experiment are not convincing.

In the first place, the new system was introduced in the Santa Fe shops just after the collapse of a lengthy strike of machinists. Shop forces were demoralized and maintenance costs abnormally high, because of the inevitable employment of incompetent men to take the place of the strikers. A return to normal conditions, under any system, would have shown a marked improvement when results were compared with the former abnormal period.

In the second place, the introduction of high-speed steel for tools for cutting and drilling was coincident with the installation of Mr. Emerson's system, altho not one of its distinct or unique features. High-speed steel was in general use before that time in other railroad shops; in fact, railroads were among the first extensive users of Mr. Taylor's invention. It is certain that the Santa Fe would have adopted the new tool steel, as other roads had already done, even had Mr. Emerson's system not been adopted. Mr. Taylor's new steel revolutionized the art of cutting metals and very much reduced shop costs. A large part of the Santa Fe saving, therefore, was due as much to high-speed steel as to the new system of management.

In the third place, Mr. Emerson's usual method of expressing the expense of locomotive maintenance is in cost per "road unit." This is an unusual and misleading average because it includes the weight of the locomotive as a factor and assumes that the repair cost varies directly with the weight. It assumes that an engine weighing one hundred tons will cost twice as much to repair as one weighing fifty tons. This assumption is not entirely incorrect; it is true that a heavy engine costs somewhat more to maintain than a light one. But the cost of repairs does not vary directly with weight. In this case, Mr. Emerson's unit gave a favorable showing to the new system, because of the purchase of a large number of new and heavy locomotives during the first two years under his régime. Naturally, the new engines did not call for the same measure of repair work as the older ones, which had kept up the cost in the previous period with which the comparison was made.

The unsatisfactory character of the ordinary accounting unit, "cost of repairs per locomotive mile," is recognized. Yet, with a knowledge of conditions, it is a better index than the Emerson unit, which assumes that cost varies directly with weight. The most reliable indication of cost of maintenance is afforded after all by the "per mile" and "per year" figures in the annual reports. In the figures tabulated below, comparison is made between the Santa Fe and the Union Pacific, running through similar territory to the north, and also the Southern Pacific, running through similar territory to the south. It will be noted that the Santa Fe costs have been steadily higher since 1903 than those of either of the Harriman lines. Taking the average of the seven-year period following the introduction of the new system on the Santa Fe (1904–10), its "per mile" costs are 20% higher than the Union Pacific and 14% higher than the Southern Pacific.

COST OF LOCOMOTIVE REPAIRS AND RENEWALS

Year	*per mile*			*per locomotive*		
	Santa Fe	Union Pacific	Southern Pacific	Santa Fe	Union Pacific	Southern Pacific
1903	9.97c.	10.39c.	8.62c.	$3,042	$3,590	$3,289
1904	13.42	11.23	10.33	3,772	3,565	3,588
1905	14.87	11.56	11.23	4,165	3,791	3,473
1906	11.08	8.61	11.26	3,101	3,068	3,531
1907	10.50	8.66	10.48	3,037	2,933	3,563
1908	13.74	10.70	10.79	3,714	3,108	3,234
1909	11.95	11.50	11.85	3,133	3,149	3,182
1910	12.87	11.72	11.63	3,832	3,656	3,551

In his testimony before the Interstate Commerce Commission Mr. Emerson referred to the time taken to give a locomotive shop repairs. By his system the time was reduced from sixty to thirty days. To the uninformed public this would seem a gratifying accomplishment. But even thirty days is too long. Many of the railroads do better. On the Chicago

& North Western, for instance, the average is fifteen days. In this case again the improvement is relative only. The final results are no better than the average of other roads, nor as good as those of roads which are very well managed.

Since the Santa Fe experiment lacks convincing proof, the railroad manager must turn to the records of the manufacturing establishments where scientific management is known to be eminently successful. The impulse of the railroad man, as well as of the manufacturer, is to acknowledge the benefits of the system elsewhere, but to doubt that it can be successfully applied to the complex details and difficulties of *his* business with which the efficiency experts cannot be intimately acquainted. His first answer usually is, " This may work elsewhere, but not in my plant." But open-minded railroad men, while admitting that they may be giving a stereotyped objection, and that in the course of years some roads may find features of value in the system of management thus rudely brought to their attention, may nevertheless urge with good reason that especial difficulties stand in the way. The success of scientific management in commercial undertakings does not in itself prove that the new system would be equally effective in railroad work. The essential differences between railroads and manufacturing establishments must be borne in mind. These differences may be summarized under four headings: (1) area and extent of activity; (2) nature of product or output; (3) relations with the public and the government; (4) relations with labor unions.

(1) The differences in area and extent of activity are obvious: the manufacturing establishment with its concentrated forces and intensive activity; the

railroad with its long lines of communication, scattered units of organization, and extensive range of action. Railroad forces, spread out thinly over the line, necessarily work under scant supervision. Section forces, stationmen, signal and repair men, car inspectors and oilers, work-train and way-freight crews, and many other employees located in small groups at intervals of two or three miles, must be left largely to themselves, and their work checked chiefly by inspection. It is obviously impracticable to afford the constant supervision which is such a vital part of the new system. In a manufacturing plant thousands of men may work in one group of buildings, subject to the supervision not only of gang bosses and foremen, but also of all officers and owners of the establishment. In contrast, compare the one item of section forces. Gangs of six to ten men are scattered over every section of three to ten miles, the average being one man per track mile. This attenuated line of two or three thousand laborers on a double-track road, say, from Boston to Chicago, a distance of more than a thousand miles, could be concentrated on one acre in a textile mill.

(2) With respect to the nature of product or output, there are also distinct differences between an industrial establishment (such as the Tabor Manufacturing Company), with a uniform output, and a railroad repair shop, where there is little uniformity in the work. The cost of the work in a railroad shop is a small part of total operating expenses.[1] Shop and repair work is *incidental* to the main function of producing transportation. The value or efficiency of railroad shop work depends upon how well it assists

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[1] The cost of maintaining locomotives and cars averages about 18% of operating expenses.

in the safe and expeditious movement of passengers and freight. It cannot be systematized to the same degree as in manufacturing shops, where the character of the work varies but slightly. Oftentimes, too, it is much more important that railroad repair work be done quickly than at the lowest possible cost. This feature applies particularly to repairs made at the engine houses and outlying car inspection points.

In railroad shops which carry on the manufacture (as well as the repair) of locomotives and cars, it would be practicable to adopt a large part of Mr. Taylor's system. But such shops are relatively few in number. The great majority of the railroads find it cheaper to purchase their rolling stock, because the best use of the railroad shops and the mechanical department organization is to maintain, not to manufacture. It has been found that they cannot compete on even terms with an industrial concern which specializes in manufacture.

(3) Quite apparent, also, are the dissimilarities between railroads and private concerns in their relations to the public and governmental regulating bodies. A railroad is a public service corporation. The public rightfully demands that adequacy of service shall outrank the payment of dividends. A manufacturing establishment exists solely for profits. If it ceases to be profitable, it may close its doors or change the nature of its business. The operation of an unprofitable road must continue. It has two functions, public service and profit making; it may not neglect service to favor profits. Necessarily, therefore, methods are employed in the interest of public service even tho they involve economic loss, and would not be resorted to if railroads were operated as private industries.

For example, parallelling lines, trolley competition, or other changed conditions may make certain divisions, branches, or trains unprofitable; yet satisfactory service must be continued, with little thought of returns. The losses from such divisions, branches, or trains are perforce absorbed in the earnings of the trains which are better patronized. Again, the demand for prompt and regular movement of freight often results in cars being moved with a light load. If they were held for a full load, the regularity of the service would suffer. As a result only one third of the capacity of freight cars is utilized.[1] In other ways economies in railroad operation could be brought about at the expense of the service; but these are desired neither by the railroads nor the shippers.

The effect of governmental regulation is much more apparent in railroad operation than in private industries, and, while both proper and desirable, it adds to the cost of operation. Mr. Howard Elliott, president of the Northern Pacific Railway, recently[2] stated that the cost to the railroads of the United States for board and commission control amounts to $85 per mile of road per annum, an aggregate of $20,000,000. This regulation affects nearly every detail of operation. Tho justified by public policy, and apparently necessary to keep *all* the railroads up to a standard which the well managed might adopt without governmental requirement, it has an important bearing on any comparison which may be made between railroads and manufacturing establishments not so circumscribed.

For the safety of trains, again, every precaution must be taken to avoid accident. Methods which

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[3] The average capacity of freight cars in the United States is 35 tons. The average ton miles per loaded car mile is 19.3.

[2] Address before the Minnesota Federation of Commercial Clubs, January 26, 1911.

might reduce costs but which would also add to the element of risk are necessarily barred. For that reason certain classes of work are performed under day rates rather than by piece work. It is more important to have the task well done than to make a slight saving in cost. One accident as the result of such apparent economy would offset the savings of a long time.

(4) Perhaps the greatest barrier to the introduction of any system designed to accomplish savings which will diminish the number of employees is the labor organization. Practically every branch of the railroad service is strongly organized and militant. The manufacturer has his labor problem also; but he can close down his plant or lock out his men if he sees fit. With railroads, resistance to demands considered by them as unreasonable must not be allowed unduly to affect service. Trains must be kept moving at any cost, and if men cannot be had to take the place of striking employees, or if, before a strike is declared, it is plain that resistance is useless,[1] the company must make the best terms it can, and maintain peace.

Any system or contrivance which has for its object the creation of competition among workmen, or which will cause them to exert themselves, is repugnant in principle to labor leaders. Its direct result, as they see it, is to "speed up," and to lessen the number of workmen. Their attitude is indicated by the strong opposition of the Brotherhood of Locomotive Engineers to the introduction of the Mallet compound locomotive. This type of machine is capable of handling very much heavier trains, but calls for no more effort and very little additional skill on the part of the engineman. The organization held out strongly for double pay, on the thoery that the Mallet engine does twice the work of an ordinary engine and, if ordinary engines were used instead, double the number of enginemen would be necessary. The issue came near precipitating a strike on all the western lines last fall, but was finally settled by mediation under the Erdman Act, the enginemen receiving a bonus of $1 per day over the highest existing rate, instead of double pay as demanded. This settlement, however, will hardly be permanent. Opposition will probably continue and the question will undoubtedly cause friction in future negotiations between the railroads and their enginemen.

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[1] This was the situation a year ago on the Baltimore & Ohio, Lackawanna, and New York Central roads.

Of similar significance are the organized efforts of conductors and trainmen to prohibit double-heading. By this is meant the practice of running two engines on a freight train so as to increase its length. The resulting decrease in the number of trains and the consequent smaller number of train crews are opposed by the men.

The year 1910 saw the successful culmination of an ambitious plan to "standardize" the wages of conductors, trainmen, and yardmen in the eastern states, that is, to set a uniform rate per day, per hour, or per mile for each class of service, regardless of local conditions.[1] The road with the highest wage scale (the Baltimore & Ohio) was selected as the battle ground, and the entire forces of the train-service brotherhoods focussed upon it in a demand for new and unreasonably high rates. To prevent a strike, the railroad invoked the aid of the Board of Mediation (under the Erdman Act), and the award, while not granting the rates demanded, carried with it substantial increases over rates already considerably higher than those of other roads in the East with distinctly different operating characteristics. The new basis was then in turn forced upon practically every road in eastern territory. The increases in New England averaged between 20% and 30% and in some cases exceeded 50%. At the same time long-standing differentials between different grades of employees were seriously disturbed. Throughout, the new wage basis and working rules (prescribed partly by governmental mediation) are far from scientific or equitable.

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[1] See a paper by the present writer on "Standardizing the Wages of Railroad Trainmen," Quarterly Journal of Economics, November, 1910.

At this writing (April, 1911) the boiler makers of the New York Central lines have been on strike for ten weeks because of the introduction of piece-work rates at Collinwood, Ohio, on the Lake Shore Railway. Undoubtedly, former abuses of the piece-work basis have much to do with the determined opposition to its introduction in this case. Yet the same opposition would probably have occurred if it had been the Emerson bonus plan used on the Santa Fe. In fact, the head of the strongest organization in railroad service is reported as having said that the bonus system and his organization could not exist together on any railroad.[1]

These difficulties, serious as they are, may be met by experts. But the railroad man sees no definite plan for the application of the new "principles"; and he has a fondness for the concrete. After studying scientific management as applied to shops he realizes that when similar efforts are made to extend it to the whole line of railroad operation, long and expert study will be needed, and new and unsuspected modifications of the system must be made to meet the exacting conditions of railroading.

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[1] Warren S. Stone before the National Civic Federation, January 12, 1911.

The technical record of railroads in the United States is creditable. They have had to meet exceptional difficulties. In their effort to keep pace with the commercial development of the country, a policy of expediency has in many cases justified standards of construction, maintenance, and operation which would have been considered faulty in an older country, like England, whose railroads came after, not before, her industrial growth and dense population. But in the past two or three decades many deficiencies have been corrected and the work of eliminating other imperfections is progressing.

In the interest of a clearer understanding of the situation by the public, it would have been worth while for the railroads to offer more of constructive evidence to show that altho scientific management, as a system, has not been adopted by them, yet the principles of sound business management have free play in a large number of shops and other railroad operating activities. So far from being ignorant as to costs, many roads have statistical departments which compile and disseminate information upon every detail of operation, so that each unit of efficiency may be compared with other units, or with the same unit of another division, another railroad, or another period. Instead of being out of date in shop equipment, or behind the time in shop practice, they are, on the average, in advance of manufacturing establishments. They might have shown further that railroads, while far from perfect, are constantly improving in efficiency; that railroad officers, both of the so-called "practical" school and those who are graduates of colleges and technical schools, are earnest in their effort and have ample incentive to operate economically. Railroads believe in and practise the free and frequent exchange of ideas by associations and clubs which include every branch of the service. In fact, they are unique in having so few secrets concerning operating methods, and in their willingness to tell of, hear about, and profit by their mutal experiences.

As an illustration of the work of one association, witness the monthly reports of the Car Efficiency Committee of the American Railway Association. The statistical exhibit, showing every detail of operation and revenue connected with freight movement on every railroad in the country, is a convincing example of the scientific thoroness with which such information is compiled and distributed for mutual benefit. Every department has its association doing similarly scientific work. As other instances, take the Railway Engineering Association and its careful studies and experiments in perfecting rail design and cross-tie preservation; the Master Car Builders' Association and its exhaustive tests of air-brake apparatus; the Master Mechanics' Association and its painstaking efforts to evolve a perfect super-heater and mechanical stoker; and the Railway Signal Association and its thoro-going work of standardizing the art of signaling.

There may be ground for the impression that railroads are in a class by themselves in an attitude of self-sufficiency, that is, a belief that they can learn little from the experience or ideas of those outside the railroad circle. Yet that this is not altogether true, and that the railroads not only welcome but seek assistance from outside experts, is shown by the establishment of the Bureau of Explosives. This bureau was organized under the auspices of the American Railway Association about five years ago by

Colonel Dunn of the ordnance department of the United States army, working closely in conjunction with the late Dr. Dudley (then chief chemist of the Pennsylvania Railroad) and a committee of other railroad officers from different sections of the country. The American Railway Association realized that they did not have a man within their ranks with the same wide knowledge of the characteristics of explosives and the best manner of handling them, and were glad to secure Colonel Dunn's valuable services. He has accomplished much in organizing a system and formulating rules of inspection which have reduced to a very large extent the accidents formerly frequent in the transportation of this dangerous class of freight.

In the committee work of the Railway Engineering Association, Master Car Builders, Master Mechanics, Signal Engineers, and other railroad technical associations, the coöperation and active assistance of outside experts is sought. There are eleven university professors on the various committees of the Railway Engineering Association. In the active work of the railroad mechanical associations there are as many more, notably Dean Goss of the University of Illinois, Professor Hibbard of the University of Missouri, and Professor Benjamin of Purdue University.

The railroad man, knowing how keen is the anxiety of his profession for improvement and vigilance, has been and is proud of the achievements of American railroads. He believes that railroad efficiency is higher than the average in manufacturing establishments, and can hold its own with any line of enterprise in the United States. He thinks, too, that in the recent rate hearings the railroads should have been measured not with the exceptional industrial establishment, but with the average. He recognizes, none better than he, the existing deficiencies in railroad management; but that they are greater or more flagrant than those in other large undertakings he will not admit. The extended area of railroad activity and the problem of adequate supervision make it difficult to secure high efficiency and use of materials. The tendency of labor union policy is increasingly to trammel the manager. He is also hampered by the difficulty of securing competent men in supervisory positions. Expert knowledge is not required to point out losses and inefficiencies. They are apparent. But criticism should be accompanied by practical remedial suggestions.

The history of American railways shows that their progress has been steady and substantial. A comparison of any two periods ten years apart will reveal impressive increases in efficiency. The net train load, for example, has increased nearly fifty per cent in the last ten years. Such advances in nearly every case have been the result of development and improvement of existing methods and facilities. The new and improved have been the adaptation of the old. And judging by this steady improvement in the past, it may be expected to continue in the future.

The solution of the problem of how to effect further economies and yet maintain good service seems to lie in a more rigid application of the railroad's own kind of scientific management and a continuation and enlargement of the best practices of the best railroads, so that the operating results of the least economical may approach those whose efficiency is marked, and these in turn set new and higher standards. *A new system is not needed so much as a more determined, and a more general application of the sound and business-like* *methods which have already been found effective in railroad work.*

After all, there is little essential difference between the aims and accomplishments of scientific management as advocated by the new experts and scientific management as practised by the exceptionally well-managed railroads. As a system, it means a careful study and analysis of each element of operation, and the application of the methods best adapted to bring about the best results under the given conditions. Many railroads are doing this successfully; others are doing it in part. In the nature of things, however, their efforts have been directed more to the " high spots " or to those features of operation which are most in need of correction or which promise the largest or quickest returns. Scientific management, as a system, takes a broader view and requires that the same careful study and treatment be given to every detail of operation as is given, say, to the subject of train loading. Obviously, there is a point where this would be unprofitable, — where the cost of the system would exceed the saving.

The real difference, then, between the efficiency experts and the railroads in their conception of scientific management is not in kind but in degree. To find a common ground means mutual concessions. On the part of the efficiency expert it will require less stress upon " system," " principles," " dependent sequences "; it will require more knowledge of the practical problems of railroads, more respect for what the railroads have accomplished, and less exaggeration and generalization concerning waste and possible savings. On the part of the railroad a more receptive attitude is needed for suggestions from the outside and a recognition of the fact that, notwithstanding commendable progress in operating economies, much yet remains to be accomplished.

Among the important features of Mr. Taylor's system of shop management, the principle of time study might well become a part of the practice of any railroad shop with a piece-work basis. The piece-work schedules of today are generally an evolution from "cut and try" methods. Their defects are recognized. Mr. Taylor's second principle, of standardized conditions, is equally important, and many railroad shops come reasonably close to standard practice.

But apart from shop operation, other and greater avenues of economy are being earnestly studied. The delays and red-tape obstruction to local initiative,[1] will yield to some plan of decentralizing authority, such as is now being tried on the Harriman lines. There are undoubted economies in further standardizing of equipment and materials, as well as in improved methods of storing and distributing supplies. There is promise of economy in the experiments now being made by the American Railway Association in clearing-house accounting for joint use of cars. A substantial saving in fuel may be made by a more general adoption of the methods of the roads having the best fuel records. And throughout the service there is crying need for more and better supervision.

Better supervision calls for better men, and to that end the educational activities of the railroads should have wider scope and more effective organization.[1] A system of management is not needed so much as managers. The system is not as important as the man. A good system will not altogether save a poor manager, nor will an imperfect system altogether hold back one who is ambitious and able. Mr. Taylor himself recognizes this in his statement, "the first object of any good system must be that of developing first class men."[2]

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[1] Mentioned by W. M. Acworth, the English economist, as a defect in American railroad organization. In the same statement, made on the eve of his departure February 1st last, he expressed surprise that the newspapers should give so much space to criticism of railroad efficiency. In his opinion American railroads are the most efficient in the world. He believes that the skeletons in the railroad cupboards have all been buried and that now the roads "would do well to open their cupboards and let the public see how sweet and clean they are."

Except in the important particulars of time study and functional foremanship, the system advocated by the experts and the system practised by the railroads are not very far apart. Both have for their object that which is desired by the railroads and the public, — ability to give good, safe, and economical service. And if achieved either by an improvement of present methods, or by an adaptation of the new system, private management of railways will have strengthened its claim to continuance.

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[1] J. Shirley Eaton, in "Education for Efficiency in Railroad Service" (1909), says: "In the course of railroad development, there was a first era, which was the era of railroad building. Any railroad was better than a wagon road. There was next an era of coördination of the railroad service and finance to the commercial and financial conditions as a whole with which the railroads were called upon to deal. This was the time of the traffic organization and railroad consolidation. Next came the era of internal adjustment on the physical and mechanical side — perfection of machinery, cutting down grades, strengthening bridges, increasing the train unit. And now has come the sociological adjustment. The human part of the machine is quite as vital as the steel and wooden part in producing efficiency, and so in increasing the income."

[2] American Magazine, March, 1911, p. 570.